Claims

[c1] A tool system (212) for monitoring a flow of liquid within a borehole (202) comprising:

a plurality of tools (201, 203, 204, 205, 207) disposed on a longitudinal axis of the tool system (212), the plurality of tools (201, 203, 204, 205, 207) comprising at least a first injector tool (201) for ejecting in the borehole (202) a tracer and a detector tool (203) to detect the ejected tracer;

a standard digital bus (206) traversing at least a portion of each tool of the plurality of tools (201, 203, 204, 205, 207), the standard digital bus (206) allowing a communication between each tool of the plurality of tools (201, 203, 204, 205, 207).

[c2] The tool system (212) according to claim 1, wherein the plurality of tools (201, 203, 204, 205, 207) comprises a control tool (207) to manage data exchanges through the standard digital bus (206).

[c3] The tool system (212) according to any one of claims 1 to 2, wherein the plurality of tools (201, 203, 204, 205, 207) comprises a second injector tool (205) located on an opposite side of the detector tool (203) of the tool system (212) as compared to the first injector tool (201) so as to allow to detect a possible reverse flow in the borehole (202).

[c4] The tool system (212) according to any one of claims 1 to 3, wherein the plurality of tools (201, 203, 204, 205, 207) also comprises a third injector tool (204) distinct from the first injector tool (201), the third injector tool (204) being located on the same side of the detector tool (203) in the tool system (212) as the first injector tool (201).

[c5] The tool system according to any one of claims 1 to 4, wherein
the borehole has a longitudinal direction that is substantially horizontal;
the plurality of tools also comprises an orientating tool to measure an orientation of at least an ejection port of the first injector tool.

[c6] The tool system according to any one of claims 1 to 5, wherein the first injector tool comprises a first group of electrical wires corresponding to the standard digital bus and at least one standard connector allowing to removably connect the first group of electrical wires to a second group of electrical wires corresponding to the standard digital bus within a distinct tool from the plurality of tools.

[c7] The tool system according to claim 6, wherein both the first group of electrical wires and the second group of electrical wires comprise two power wires dedicated to power transportation and two signal wires dedicated to signal transportation.

[c8] A method for monitoring a flow of liquid within a borehole (202) comprising:
providing a plurality of tools (201, 203, 204, 205, 207) on a longitudinal axis of the borehole (202);
linking the tools with a standard digital bus (206) allowing a communication between each tool of the plurality of tools (201, 203, 204, 205, 207);
ejecting a quantity of tracer using a first injector tool (201) among the plurality of tools;
detecting the ejected tracer using a detector tool (203) among the plurality of tools.

[c9] The method of claim 8, further comprising:
managing data exchanges through the standard digital bus using a control tool (207) among the plurality of tools.

[c10] The method according to any one of claims 8 to 9, further comprising:

detecting a possible reverse flow in the borehole using a second injector tool (205) among the plurality of tools, the second injector tool (205) being located on an opposite side of the detector tool (203) as compared to the first injector tool (201), the second injector tool (205) communicating with the detector tool (203) using the standard digital bus (206).

[c11] The method according to any one of claims 8 to 10, further comprising measuring an orientation of at least an ejection port of the first injector tool with an orientating tool among the plurality of tools.

[c12] An injector tool (303) for ejecting a tracer in a system for monitoring a flow of liquid within a borehole, the injector tool (303) comprising:
measuring means (310) to measure an ejected quantity of the ejected tracer.

[c13] An injector tool (303) according to claim 11 further comprising:
a body (311);
a piston (307) to expel the tracer;
wherein the measuring means (310) measure a displacement of the piston (307) relative to the body (311).

[c14] An injector tool (303) according to claim 13, wherein the measuring means (310) comprise:
at least one magnetic ring (301) mounted on the piston (307);
a plurality of Hall Effect switches (309) mounted on the body (311).

[c15] An injector tool according to claim 14, wherein
three magnetic rings (402) are mounted on the piston;
the Hall Effect switches (401) are organized into four independent arrays; and
the Hall Effect switches (401) belonging to a determined array are tied to a single determined wire (403a, 403b, 403c, 403d).

[c16] An injector tool (303) according to any one of claims 12 to 15, further comprising:
a reservoir (304) into which the tracer is stored;
an opening (312) through which the tracer may be ejected from the injector tool (303);
an electro-valve (305) to control the opening (312);
actuating means to move the piston (307) such that the piston (307) moves when the electro-valve (305) opens the opening (304) and the tracer is ejected.

[c17] A tool system for monitoring a flow of liquid within a borehole comprising an injector tool (303) according to any one of claims 12 to 16.

[c18] A method for monitoring a flow of liquid within the borehole comprising:
ejecting a tracer with an injector tool (303) located within the borehole;
measuring an ejected quantity of the ejected tracer.

[c19] The method according to claim 18 further comprising:
detecting the ejected tracer with a detector tool located within the borehole.

[c20] The method according to claim 19, further comprising:
receiving downhole a value of a desired quantity of tracer (501);
starting the ejecting of the tracer (502);
comparing the measured ejected quantity of tracer with the value of the desired quantity (505);
interrupting the ejecting if measured ejected quantity substantially equals the value of the desired quantity (506).

[c21] The method according to claim 20 further comprising:
initializing (502) a counter at the starting of the ejecting;
incrementing (504) the counter while the tracer is being ejected; and

transmitting (507) a value of the counter to a surface system at the interrupting of the ejection, the value of the counter being a function of a duration of the ejecting.

[c22] An injector tool (601) for ejecting a tracer in a system for monitoring a flow of liquid within a borehole, the injector tool (601) comprising:

a first group of hydraulic parts (603, 610, 616) intended to be in contact with the tracer;

a second group of electrical elements (604, 605, 617);

wherein the hydraulic parts of the first group may be accessed and replaced during a maintenance operation; and

wherein the electrical elements of the second group remain protected during the maintenance operation.

[c23] An injector tool (601) according to claim 22, further comprising an electro-valve, the electro-valve (606) comprising:

an electrical portion belonging to the second group;

a solenoid seat (610) belonging to the first group;

a high pressure barrier (608) for isolating the electrical portion of the electro-valve (606) from the solenoid seat (610);

wherein the electro-valve (606) is mounted in the injector tool (601) such that the solenoid seat (610) may be accessed without removing the electrical portion.

[c24] An injector tool (601) according to claim 22, further comprising

electrical wires (605) belonging to the second group;

a connector (620) allowing to connect the electrical elements of the second group with other electrical elements of a distinct tool, the connector comprising a first portion (612) and a second portion (613), wherein the first portion

(612) may be removed during the maintenance operation and wherein the second portion (613) continues to protect the electrical wires (605) during the maintenance operation.

[c25] The tool system according to any one of claims 1 to 7, wherein at least the first injector tool is an injector tool according to any one of claims 12 to 16.

[c26] The method of claim 8, further comprising :

activating an injection counter at the ejecting of the tracer;

incrementing the injection counter at an acquisition frequency, the acquisition frequency being independent from a communication frequency of the communication between the plurality of tools (201, 203, 204, 205, 207);

reading a value of the injection counter to evaluate a time duration between the ejecting and the detecting.